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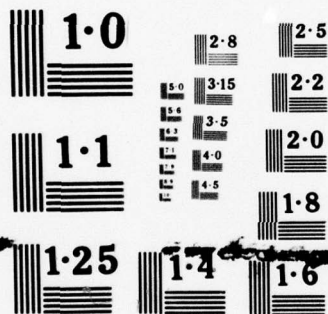
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NEEDS AND AREAS OF POTENTIAL APPLICATION OF DISPOSAL AREA REUSE MANAGEMENT (DARM)

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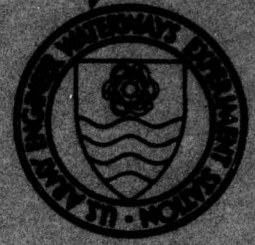
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# DREDGED MATERIAL RESEARCH PROGRAM



TECHNICAL REPORT D-78-27

## 6 NEEDS AND AREAS OF POTENTIAL APPLICATION OF DISPOSAL AREA REUSE MANAGEMENT (DARM).

by

10 Michael R. Palermo

Environmental Laboratory  
U. S. Army Engineer Waterways Experiment Station  
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11 JUNE 1978

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Washington, D. C. 20314

Under DMRP Work Unit No. 5C09

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15 August 1978

SUBJECT: Transmittal of Technical Report D-78-27

TO: All Report Recipients

1. The report transmitted herewith is a result of a work unit initiated as part of Task 5C (Disposal Area Reuse Research) of the Corps of Engineers' Dredged Material Research Program (DMRP). Task 5C was part of the Disposal Operations Project of the DMRP and among other considerations included developing methods to extend the useful life of confined disposal areas.
2. Confining dredged material on land is a disposal alternative to which few specific design or construction improvement investigations have been addressed. There has been a dramatic increase within the last several years in the amount of land disposal necessitated in part by restrictions on open-water disposal. In order to minimize the amount of land required for the confined disposal areas, a significant portion of the work in the DMRP was aimed toward identifying ways of increasing the capacities of containment areas.
3. One concept considered was that of the reusable disposal site, meaning that a disposal site would act primarily as a rehandling basin from which the material would be removed and put to a productive use. This study (Work Unit 5C09) was initiated to provide a better indication of the need for and areas of potential application of disposal area reuse management (DARM). This study is considered valuable since input from the Districts was obtained and used in formulating the overall DARM concepts.
4. A total of nine Corps of Engineers Districts were surveyed. Ideas regarding DARM concepts were discussed and exchanged with the Districts. It was found that critical shortages of confined disposal capacity now exist in many areas throughout the country; however, Districts are generally reluctant to restore sites through DARM in cases where providing a disposal site is viewed as the sole responsibility of the project sponsor. Acquisition of additional disposal sites is considered by the Districts to be the most economical solution to shortages of capacity.

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5. Where responsibility for providing disposal sites lies with the government, DARM should generally be viewed as a viable alternative to acquisition of additional sites provided the technical constraints can be resolved and economic feasibility can be established. The technical feasibility of full-scale application of DARM has been demonstrated by the success of ongoing programs in the Philadelphia and Sacramento Districts. These programs are documented in this report. At both of these sites, the dredged material is primarily coarse grained. In areas where fine-grained material predominates, technical constraints concerning dewatering, removal, and transport must be resolved before DARM concepts can be implemented on a large scale.

6. The results of this study will be used in the development of guidelines for DARM. The final guidelines will be presented in a report synthesizing all work conducted under Task 5C.

*John L. Cannon*

JOHN L. CANNON

Colonel, Corps of Engineers  
Commander and Director

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20. ABSTRACT (Continued).

A total of nine CE Districts were surveyed and discussion and exchanges of ideas regarding DARM concepts were made with the Districts. It was found that critical shortages of confined disposal capacity now exist in many areas throughout the country. However, Districts are generally reluctant to restore sites through DARM in cases where provision of disposal sites is viewed as the sole responsibility of the local sponsor. Acquisition of additional disposal sites is considered to be the most economical solution to shortages of capacity.

Where responsibility for providing disposal sites lies with the government, DARM is generally viewed as a viable alternative to acquisition of additional sites, provided the technical constraints can be resolved and economic feasibility can be determined. The technical feasibility of full-scale application of DARM is demonstrated by the success of ongoing programs in the Philadelphia and Sacramento Districts. Removal and sale of large quantities of material from disposal sites in the Philadelphia District has significantly extended the design life of the sites and returned revenues to the government. The Sacramento District has implemented a model DARM program which involves periodic restoration of site capacity by removal of all dredged material from the sites for use as highway fill. These programs involved predominantly coarse-grained material in a ready-to-use condition. In areas where fine-grained material predominates, technical constraints concerning dewatering, removal, and transport must be resolved before DARM concepts may be implemented on a large scale.

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## PREFACE

This report presents the results of a survey of Corps of Engineers Districts for needs and areas of potential application of Disposal Area Reuse Management (DARM). The investigation was conducted as part of Work Unit 5C09 of the U. S. Army Engineer Waterways Experiment Station (WES) Dredged Material Research Program (DMRP), sponsored by the Office, Chief of Engineers, and administered by the Environmental Engineering Division (EED) of the Environmental Laboratory (EL).

This investigation was conducted during the period December 1974 to February 1977 by Mr. Michael R. Palermo, Design and Concept Development Branch (DCDB), EED.

This study was prepared under the direct supervision of Mr. Raymond L. Montgomery, Chief, DCDB, and Mr. A. J. Green, Chief, EED, and general supervision of Mr. Charles C. Calhoun, Jr., Project Manager, Disposal Operations Project, DMRP, Dr. Roger T. Saucier, Special Assistant, EL, and Dr. John Harrison, Chief, EL.

Appreciation is expressed to the District personnel contacted during the survey for their assistance with the study.

The Directors of WES during the study and preparation of this report were COL G. H. Hilt, CE, and COL J. L. Cannon, CE. Technical Director was Mr. F. R. Brown.

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CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)  
UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
acres	4046.856	square metres
cubic yards	0.7645549	cubic metres
feet	0.3048	metres
miles (U. S. statute)	1.609344	kilometres

NEEDS AND AREAS OF POTENTIAL APPLICATION OF DISPOSAL  
AREA REUSE MANAGEMENT (DARM)

PART I: INTRODUCTION

Background

1. Millions of cubic yards of sediment must be dredged annually to maintain navigation channel depths because of the effects of shoaling. In past years, a majority of dredged material was disposed of in open water or on wetlands. However, in recent years land disposal of dredged material in confined areas has increased, primarily because of the environmental constraints placed on open-water and unconfined wetland disposal.

2. As a result of this trend, the acquisition of suitable confined land disposal sites has become a significant problem for Corps Districts and Divisions.<sup>1</sup> Most disposal areas which are ideal from an operations viewpoint are located within the estuarine zone where there are already excessive and often conflicting land-use requirements. Land use solely for a form of waste disposal cannot continue at the present rate.

3. Confined disposal areas have been acquired by direct purchase but more often are provided by the project sponsor or local interest groups which may be a county, city, port commission, state, or other responsible body.<sup>2</sup> The sponsor must provide an agreement or easement for land use and may be required to construct retention dikes and other facilities. Repair and maintenance of the disposal facilities usually are accomplished at Corps of Engineers (CE) expense. The increased use of confined disposal, coupled with the rapid depletion of available sites, has given rise to considerations of new policy. There is presently a consideration of giving authority to the CE to acquire and maintain containment areas for long-range requirements.

4. Under the CE Dredged Material Research Program (DMRP), a new dredged material disposal concept is being investigated--disposal area reuse management (DARM). The reusable dredged material disposal area is

essentially a collection and processing site where dredged material is rehandled within the site or removed from the site, thereby increasing or restoring site capacity for subsequent disposal.<sup>3</sup> This concept is illustrated in Figure 1.

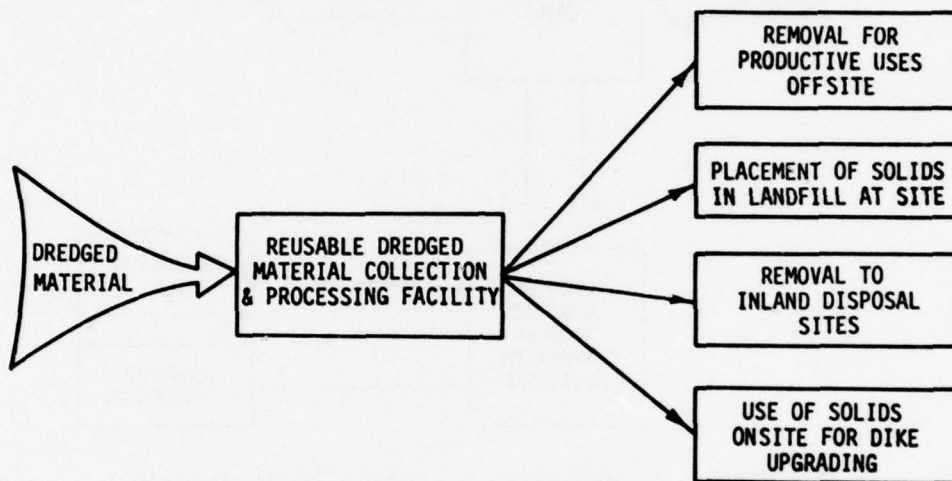


Figure 1. Flow diagram for disposal area reuse

5. The advantages of a site that can be reused are as follows: (a) permanent or semipermanent sites could be provided convenient to maintenance dredging areas; (b) the expense and objection to providing new lands for disposal sites could be minimized; (c) construction and landfill materials would be made available for productive use; and (d) a reasonable alternative is provided for solving land disposal problems and reducing the excessive use of valuable lands.

6. Rehandling or removal of dredged material from a reusable facility is dependent on improvement of dredged material properties, primarily dewatering, identification of suitable removal and transport methods, and identification of a productive use or alternate storage area for the material after removal. The DARM concepts can vary from quite simple dewatering and rehandling schemes, as shown in Figure 2, to complex processing facilities which may possibly involve separation and treatment, as shown in Figure 3. Detailed discussions of the factors concerning DARM and concepts regarding planning and design of reusable facilities are documented in other DRMP research.<sup>3,4,5</sup>



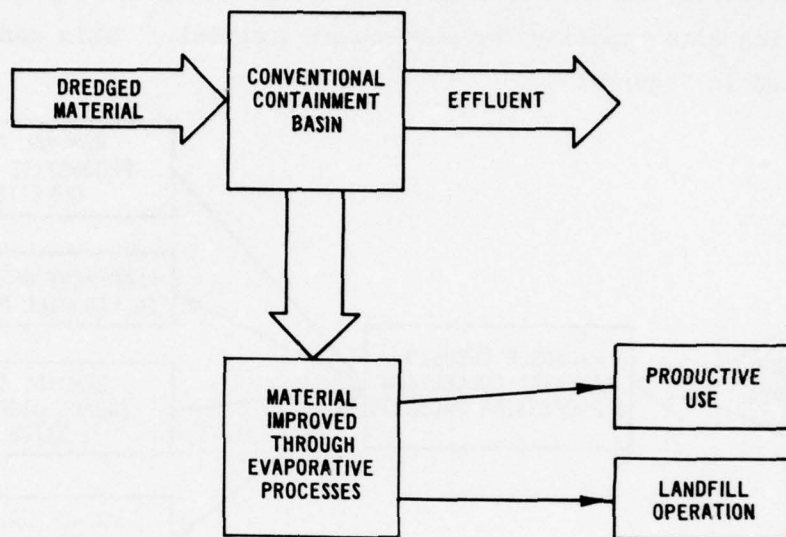


Figure 2. Rejuvenation of conventional disposal sites for reuse<sup>3</sup>

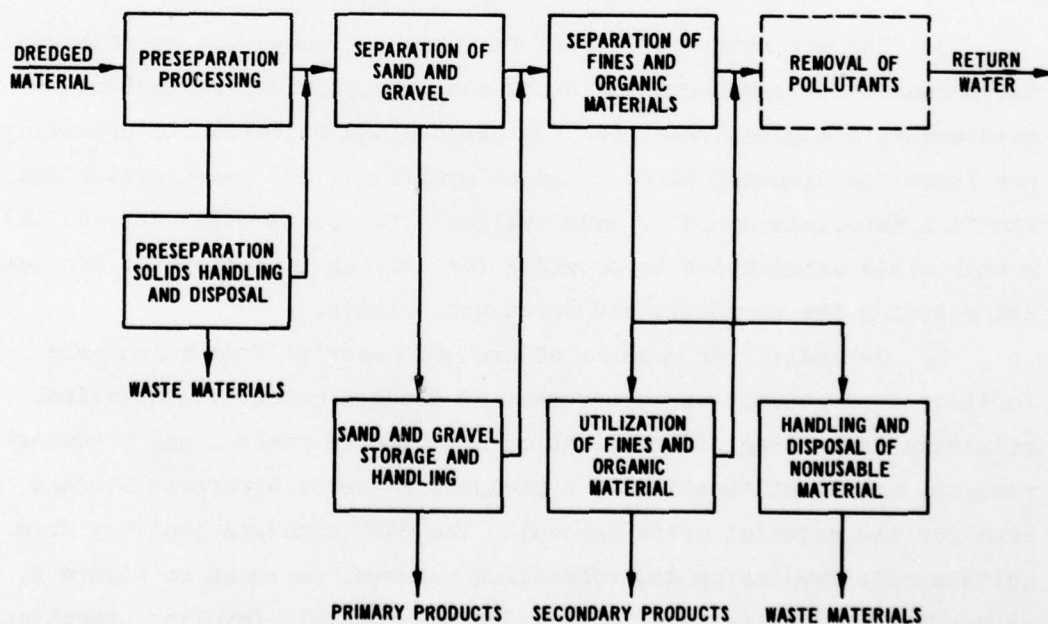


Figure 3. Functional diagram for disposal area reuse involving dredged material processing<sup>3</sup>

7. The DARM concept is not totally new to Corps dredged material disposal operations. Significant quantities of dredged material have been removed from disposal areas in the Philadelphia District and used for landfill purposes, greatly increasing the remaining disposal capacity of the areas.<sup>6</sup> Programs of agreement between the Sacramento District and the California Department of Transportation call for removal of all accumulated dredged material from selected disposal areas along the Sacramento River, giving these areas an infinite design life.<sup>7</sup> These examples indicate that DARM concepts can be both technically feasible and economically justifiable in full-scale application.

8. An important factor in evaluation of DARM involves its potential for widespread application within the Districts. A comprehensive survey of selected Districts was therefore undertaken by the DMRP to determine the requirements for DARM within the Districts and areas of potential application of DARM concepts developed to date.

#### Authorization for Implementation

9. The pressing need for extending the capacity of existing disposal areas on a broad scale has been recently recognized by the Congress. Provisions concerning the utilization of management practices to extend the useful life of disposal areas are included in PL 94-587:

Sec. 148. The Secretary of the Army, acting through the Chief of Engineers, shall utilize and encourage the utilization of such management practices as he determines appropriate to extend the capacity and useful life of dredged material disposal areas such that the need for new dredged material disposal areas is kept to a minimum. Management practices authorized by this section shall include, but not be limited to, the construction of dikes, consolidation and dewatering of dredged material, and construction of drainage and outflow facilities.  
(Emphasis added.)

This legislation may lead to consideration of DARM concepts as a major alternative to present confined land disposal methods.<sup>8</sup>

### Purpose

10. The purpose of this report is to document the results of a survey of Corps Districts for needs and areas of potential application of DARM. Results outlined in this report may be used as an aid in planning reusable disposal facilities and in the evaluation of DARM concepts as an alternative to conventional disposal methods.

### Scope

11. The scope of this report is restricted to the evaluation of the need for development of reusable dredged material disposal areas and the potential for application of DARM concepts within CE Districts. Disposal Area Reuse Management practices now in use by CE Districts are documented and evaluations of possible extensions of these practices to other locales are made. The potential for application of new DARM concepts developed through DMRP research is also determined.

12. Constraints associated with widespread use of DARM concepts as identified by Districts are discussed and recommendations of policy changes regarding disposal practices are made.

13. Specific methods and procedures of implementation of DARM concepts and planning and design of reusable disposal facilities are not documented in this report but are available in other reports of DMRP research concerning DARM.<sup>5</sup>



## PART II: DISTRICT SURVEY

### Survey Methodology and Reasoning

14. A total of nine Corps Districts were contacted during the period December 1974 through February 1977. Selection of Districts for the survey was based upon the relative volume of confined land disposal within the District or unique aspects of the dredged material disposal situation within the District. Location of Districts surveyed and pertinent statistics regarding confined land disposal are shown in Figure 4.

15. The survey consisted of discussions with key personnel within the Operations and Engineering Divisions of the Districts concerned directly with planning, design, construction, and maintenance of confined disposal facilities. Presentation of DMRP concepts regarding reusable disposal facilities and current DARM practice within other Districts was made to personnel concerned with dredged material disposal and also personnel concerned with complementing functions such as real estate acquisition and Environmental Impact Statement (EIS) preparation. The purpose of the group presentation format was to enlist the opinions and ideas of all personnel concerning DARM concepts and to generate discussion and exchange of ideas. Disposal areas which held promise for potential application of DARM concepts were visited.

16. Districts in which DARM practices were ongoing were surveyed initially so that these practices could be best integrated into the developing concepts concerning reusable disposal facilities and so that this information could be transmitted firsthand to other Districts.

### Philadelphia District

17. The major thrust of confined disposal within the Philadelphia District (PD) is concerned with maintenance of the Delaware River reaches from Trenton to Philadelphia and from Philadelphia to the Atlantic Ocean, encompassing the Port of Philadelphia complex and tributary projects on the Schuylkill and Christina Rivers. An average

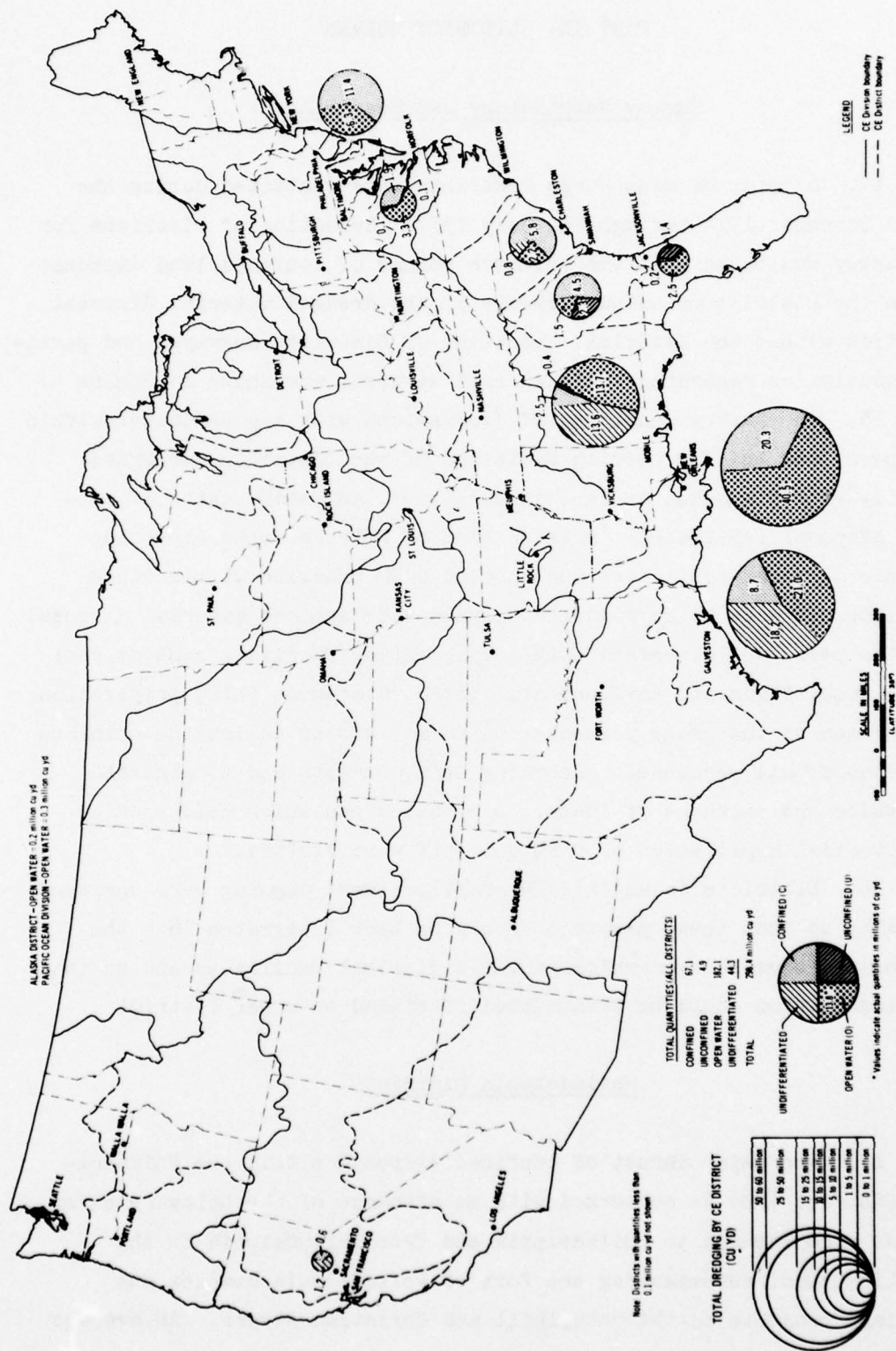


Figure 4. Districts surveyed showing disposition of dredged material generated in maintenance dredging operations and average annual quantities of material disposed (1972 data)

of 10.5 million cu yd\* of dredged material is confined each year by maintenance of these projects.<sup>9</sup> The maintenance material is primarily silts and clays with smaller amounts of sand and gravel. The PD utilizes 10 disposal areas for maintenance dredging disposal on the Lower Delaware, encompassing a total acreage of over 4000 acres, 90 percent of which is Federally owned. Disposal areas for the Upper Delaware and tributary projects are provided by the Commonwealth of Pennsylvania and the State of New Jersey and encompass a total area of over 700 acres. A summary of disposal areas and pertinent data is presented in Table 1.

18. The PD recognized as early as the middle 1960's the coming constraint on acquisition of suitable disposal areas. Increased rates of development and urbanization along the Delaware River coupled with a new environmental awareness of wetlands and other wildlife areas sharply reduced chances of easily acquiring additional sites. A comprehensive study of the dredged material disposal situation was undertaken by the PD, considering both short- and long-range solutions. This study concluded that the capacity of the Delaware sites using present disposal methods would be exhausted by 1990.<sup>6</sup>

19. A comprehensive program was initiated in 1972 to further extend the useful life of the PD disposal sites through a program of dredged material sale and use. Dredged material is sold in quantity as excess government property directly from the disposal area and subsequently used for landfill purposes. The typical procedure begins with a public announcement by the District of material available for sale. Availability is made known through use of standard General Services Administration (GSA) forms and newspaper and television advertisement. Files are maintained on all municipal and county engineers who may have a need for dredged material. Construction projects requiring large quantities of landfill material are also noted. Actual sale is made through bid invitation through the District's Real Estate Division with the contract awarded to the highest bidder.

20. Similar sales of existing foundation material have been made

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\* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 3.



from newly acquired sites to increase potential storage capacity. In one instance, the contractor erected an aggregate separation and processing plant within the disposal area right-of-way and removed processed aggregates for a specified length of time until the area was required for disposal. These operations are shown in Figures 5 and 6.

21. A total of 6,800,000 cu yd of material has been contracted for removal from PD disposal areas from October 1972 through May 1976, resulting in revenues of over \$600,000. A summary of the sales is presented in Table 2. Bids ranged from a low of \$0.08 to a high of \$0.82 per cu yd. Revenue from dredged material sales to contractors reverts to GSA and is not returned to the District budgets.

22. The PD recognizes the potential value of an extensive DARM program for the Delaware sites. Removal of large quantities of dredged material from the sites can extend the capacity well beyond the present 1990 limit. However, PD personnel caution that the related benefits and costs of DARM at the sites have not yet been established.

23. The need for effective and economical methods of dredged material dewatering is a limiting factor in large-scale implementation of DARM concepts within the PD. Success of the PD to date in the sale of material from disposal areas is based on the ability to sell usable coarse-grained material accumulated near discharge locations and fine-grained material which has been dewatered by natural forces over long time periods. No large-scale dewatering efforts have been undertaken by the PD other than periphery trenching to locally improve material for dike raising. The PD could now sell much greater quantities of dredged material if dewatering could be economically accomplished.

24. Identification of large volume markets for dewatered fine-grained dredged material is a necessary requirement before large-scale removal of material from disposal areas can be considered. Problems connected with effective marketing of the material include presence of Phragmites australis rhizomes which severely limits its use as an agricultural enhancement.

25. Legal and policy considerations regarding the sale and donation of dredged material were considered important by the PD. Required



Figure 5. Removal of dredged material from the Pedricktown Disposal Area, Philadelphia District



Figure 6. Aggregate separation and processing plant located in the Penns Grove Disposal Area, Philadelphia District

approval of dredged material sales through channels is sometimes a problem if contractors require available material on short notice. The PD has sometimes acquired advance approval for sales on the assumption that the demand would arise. Approval of sales and bidding procedures should be simplified to allow dredged material sales on a somewhat continuous basis from reusable facilities.

#### Norfolk District

##### Craney Island

26. Confined disposal of dredged material from maintenance of the lower James River and Norfolk Harbor/Hampton Roads project is centered around the Craney Island Facility, an artificial peninsula formed by diking an area of approximately 2500 acres within Hampton Roads. Title to the site was granted to the government by the project sponsor, the Commonwealth of Virginia. The annual volume of maintenance dredging from this project is approximately 5 million cu yd of predominantly fine-grained material. Craney Island can be used to confine this material until approximately 1983, at which time average elevation of the containment will reach the authorized limiting elevation of +18.0 ft mean low water (mlw).

27. Long-range plans for replacement of Craney Island originally called for a westward expansion of the facility, but this alternative was abandoned due to environmental and social/political concerns. A new 5000-acre facility adjacent to the Dismal Swamp is now being sought by the project sponsor. Disposal at this site will require retention of a portion of Craney Island as a reusable rehandling basin and long-distance pumping to the final disposal site. There are also environmental questions associated with the proposed site concerning potential leaching and groundwater contamination. Final adoption of this alternative is subject to resolution of technical problems and public approval.

28. The Norfolk District has been involved in removal of small quantities of usable coarse-grained material from the Craney Island site to partially restore capacity. Over 60,000 cu yd has been removed



periodically since 1970 and sold as excess government property. Material is removed using a conventional dragline, as shown in Figure 7.



Figure 7. Removal of coarse-grained dredged material from Craney Island Disposal Area, Norfolk District

The sale program is structured in a manner similar to the PD program, with the material purchased by local sand and gravel companies and used as fill. A summary of sales is shown below. Usable coarse-grained

<u>Bid/cu yd</u>	<u>Material, cu yd</u>	<u>Date Awarded</u>
\$0.25	4,500	Oct 70
0.25	15,000	May 70
0.30	16,890	Feb 76
0.30	13,400	Sep 76
0.50	300	Oct 76
0.30	10,250	Oct 76

material from Craney Island has also been donated to the U. S. Navy for use as fill, but no records were maintained of the yardages removed.

29. Large-scale removal of dredged material from Craney Island under a DARM program has both technical and institutional constraints. Since the majority of the material is fine grained now in a thick layer

over a poor foundation, dewatering requirements are extensive and techniques for removal of material from the site must be developed before large-scale removal would be feasible.

30. Institutional constraints on implementation of DARM concepts at Craney Island mainly concern the planned ultimate use of the facility. Although the site is Federally owned and no legal commitments exist for its transfer, plans have been made for transfer of the site to local interests upon completion of filling to the authorized elevation +18.0 ft mlw. The city of Portsmouth, Virginia, is keenly interested in the development of the site and opposes removal of large quantities of material.

#### Richmond Harbor and Deep Water Terminal

31. The Norfolk District is operating a small disposal area (12 acres) at Richmond Harbor at which DARM concepts are fully implemented and is developing plans for a similar area at Richmond Deep Water Terminal. The Richmond Harbor site is used for disposal of approximately 100,000 cu yd of sandy dredged material on an approximate 18-month dredging cycle. Between dredgings this material is removed from the basin and used for fill by the city of Richmond. This disposal area, therefore, has an infinite design life. The Richmond Deep Water Terminal site is used for disposal of dredged material composed of approximately 35 percent sand and 65 percent fine-grained material. A three-basin system is employed and coarse-grained material is generally retained in the primary basin. The site is owned by a private sand and gravel company and was made available for disposal through agreements with the city of Richmond. An access road is now under construction which will allow removal of usable material for use as fill.

#### Charleston District

##### Charleston Harbor

32. Maintenance of the Charleston Harbor project and associated channels accounts for the majority of confined dredged material disposal

in the Charleston District. Approximately 10 million cu yd of predominantly fine-grained material is dredged from the project navigation channels and basins annually. Five disposal areas located along the Cooper River are used to confine the material. Easements are provided for disposal by the project sponsor, the South Carolina State Ports Authority. Capacity of the existing disposal areas remaining under present conditions will provide for maintenance through 1986.<sup>10</sup> A summary of disposal areas and pertinent data is shown below:

<u>Disposal Area</u>	<u>Area acres</u>	<u>Method of Acquisition</u>	<u>Approximate Capacity Remaining, cu yd</u>
Daniel Island	686	Easement	10.6 million
Morris Island	703	↓	28.6 million
Drum Island	300		15.0 million
Clouter Creek	817		31.3 million
Yellow House Creek	597		28.6 million

33. The Charleston District has prepared a long-range study on dredged material for this project.<sup>11</sup> The study recommended adoption of an alternative disposal method involving removal of shoal material by a special dredge designed to utilize barges which would carry the material to ocean disposal sites. This plan is now deemed infeasible and the Charleston District is now planning to utilize additional upland sites to be provided by the project sponsor when the capacity of existing sites is depleted.

34. Charleston District personnel have been active with the DMRP in efforts to initiate dewatering and densification within the Charleston Harbor sites.<sup>12</sup> A Riverine Utility Craft of the type successfully used in DMRP field studies has been acquired by the Charleston District for use in dewatering activities. However, there are constraints associated with removal of large amounts of dewatered material under DARM concepts. Removal and transportation of material would be costly, due to the remote location of the sites. Also, suitable markets for the fine-grained material in this area have not been identified to date, even though studies have been performed indicating suitability of the material for agricultural purposes.



35. Legal considerations of ownership of dredged material in the State of South Carolina also have not been resolved. Many of the easements now in effect preclude removal of material from the site. In other cases, ownership of the site itself is in debate.

Atlantic Intracoastal  
Waterway disposal sites

36. Reuse of disposal sites within the Charleston District has been occurring in areas along the Myrtle Beach Canal Reach of the Atlantic Intracoastal Waterway (AIWW). Dredged material from maintenance of this canal is primarily sand and is pumped in temporary diked areas on private lands adjacent to the waterway. Much of this material is subsequently removed by private interests. No records as to the users or volumes of material removed have been maintained by the Charleston District.

Savannah District

37. A majority of confined dredged material disposal work within the Savannah District is connected with maintenance of the Savannah River and Harbor complexes. Over 6 million cu yd is dredged and placed in confined disposal areas from this project annually. A sediment basin and tide gate structure located opposite the city of Savannah was completed in 1972. Dredging requirements for the sediment basin and the central 7-1/2 miles of navigation channel account for over 60 percent of the total annual requirement. A summary of disposal areas in use for the project and pertinent data is summarized below. A majority of the disposal areas is used under easements through the project sponsors, the Commissioners of Chatham County, Georgia, and the Georgia Port Authority.

38. Material dredged from the upper reach of the project from the upstream limit to opposite the city of Savannah is placed in disposal areas 1A, 1B, Argyle Island, and 2A. Total remaining capacity of these areas is estimated at 40 years based on past sedimentation rates. The majority of material dredged in this reach is sand, and

<u>Disposal Area</u>	<u>Area acres</u>	<u>Method of Acquisition</u>	<u>Limit of Capacity</u>
1A	158	Department of Interior	40 years
1B	86	Department of Interior	↓
Argyle Island	298	Department of Interior	
2A	350	Perpetual Easement	
12	1260	Easement	1986
13A	1500	Perpetual Easement	1987
13B	700	Perpetual Easement	1987
14	1800	Perpetual Easement	100 years
Jones-Osterbed Island	2900	Perpetual Easement	100 years

due to its quality, considerable amounts of this material have been utilized as fill. Disposal area 1A is located on Federal lands controlled by the Department of the Interior, allowing donation of over 1 million cu yd of material to a number of agencies including the U. S. Coast Guard, Georgia Department of Transportation, and the Georgia Port Authority. Continuation of this practice may extend the disposal capacity for the upper project for a considerable period of time.

39. The lower reach of the project, below the city of Savannah, also uses disposal areas with considerable remaining capacity. The Jones-Osterbed disposal area and Disposal Area 14 (on Argyle Island) contain an estimated capacity to meet disposal requirements for approximately 100 years, based on past sedimentation rates.

40. A majority of shoaling within the Savannah Harbor project occurs within the newly constructed sediment basin and the channel reach immediately adjacent to the city of Savannah. A severe shortage of available disposal capacity is evident for this central reach. Three large disposal areas designated 12, 13A, and 13B are presently used comprising a total area of over 3400 acres. The estimated remaining capacity of the sites is less than 9 years based on normal shoaling rates. Dredged material for this reach is comprised of clays, silts, and some sands. Coarse-grained material accumulated near the discharge locations is removed by the Savannah District and used for dike maintenance and

limited dike raising as shown in Figure 8. Large-scale dike raising to increase disposal capacity is considered infeasible at this time due to extremely poor foundation conditions.



Figure 8. Removal of sandy dredged material from disposal area 13B for dike maintenance, Savannah District

41. The Savannah District views DARM concepts as a desirable means of extending disposal area capacity. The DARM is viewed as an environmentally sound method to reduce land use for disposal and as an economically desirable alternative to the projected need for additional disposal sites.<sup>13</sup> Unfortunately, there is no suitable market for the clay or silt material placed in the central disposal areas and such markets do not exist near the Savannah area. Until such markets can be identified, it is doubtful if DARM concepts could be employed to relieve the pressing shortages now evident. Technical problems concerning effective dewatering of large areas and efficient removal techniques from within large areas must also be resolved.

#### Jacksonville District

##### Jacksonville Harbor

42. Maintenance of the channel reaches of the Jacksonville



Harbor project requires dredging approximately 500,000 cu yd of material annually and placement of the material in confined disposal areas. Intensive development in the harbor and channel area and environmental considerations have combined in recent years to point out the need for a suitable long-range disposal plan.<sup>14</sup> The Jacksonville District had proposed a 20-year plan which called for a combined disposal site/recreation development on the north end of Quarantine Island. Opposition was voiced to this plan by local and State authorities, primarily due to the loss of 675 acres of open water. A 5-year plan was then adopted which called for long-range management of a 250-acre site at Quarantine Island. The DARM concepts, including possible removal of stabilized dredged material to other sites, are being considered to extend the life of the facility. The Quarantine Island site is State owned and is used by easement. Two smaller privately owned disposal areas are also used in connection with the project, the Buck & Buck disposal area and the Reid Island disposal area. The estimated capacity now remaining at the Jacksonville Harbor sites will be exhausted by 1980.

43. Some restraints regarding DARM for the Jacksonville Harbor sites have been identified. Large-scale removal of material for use as landfill or for construction purposes may be in competition with local sand and gravel operators. Recent laws enacted by the State of Florida may also influence DARM schemes which involve sale of dredged material. A fixed rate per cubic yard is now being charged for dredging on the basis of initial State ownership of bottomlands. In one instance, the local sponsor was forced to pay charges in order for the Corps dredging to be accomplished. The State also requires that dredged material be made available for bidders for possible sale. This policy may be advantageous since the State would become involved in promoting use of dredged material taken from reusable disposal areas.

#### Mayport Naval Base

44. The turning basin located at the Mayport Naval Base is maintained by the Jacksonville District. Although procurement of disposal capacity for this project is the responsibility of the Navy, the site has potential for application of DARM concepts. The disposal area now

used for the project encompasses an area of 125 acres. The annual maintenance dredging from the turning basin involves approximately 600,000 cu yd of predominantly silt and clay and also contains a high percentage of organic matter and other wastes. Additional disposal capacity at Mayport is impossible due to restrictions on further diking within wetland areas. The disposal area dikes will be raised to provide sufficient capacity until late 1978. Land access to the site is readily available, and dried material could be removed to partially restore capacity of the site.

#### Mobile District

45. A major portion of confined dredged material disposal in the Mobile District is connected with maintenance of Upper Mobile Harbor and associated channels. Maintenance dredged material for this project is placed in six disposal areas which are provided by the project sponsor, the Alabama State Docks. A summary of disposal areas and pertinent data is presented below. Average shoaling rates require maintenance dredging

<u>Disposal Area</u>	<u>Area acres</u>	<u>Method of Acquisition</u>	<u>Remaining Capacity*</u>
Pinto Island	227	Easement	--
Lower Polecat Bay	240	Easement	--
Upper Polecat Bay	85	Easement	--
Chickasaw Creek (three sites)	195	Easement	--

\* The remaining capacity of sites has not been accurately determined. The Mobile District is currently involved in a field testing program in cooperation with the DMRP involving onsite dewatering/densification and DARM to partially restore capacity.

volumes of approximately 1,350,000 cu yd annually from the upper harbor and channels. Dredged material encountered is predominantly silt and clay with small amounts of sand. Continued dredging requirements in this area are causing considerable concern due to the shortage of available land for additional containment areas.

46. Long-range disposal plans formulated by the Mobile District

included acquisition of additional lands adjacent to existing sites but were rejected because of environmental considerations.<sup>15</sup> Available confined disposal capacity is now limited to sites utilized within the past 10 years. As a result of the severe capacity shortage, the Mobile District is keenly interested in extending the useful life of existing disposal areas for the upper harbor.

47. The Mobile District is currently participating in field demonstrations of dredged material dewatering/densification techniques and possible subsequent DARM practices. The field study program is being conducted at the Upper Polecat Bay Disposal Area. A number of small-scale field demonstrations of promising dredged material dewatering techniques have been evaluated, including full-scale dewatering over a majority of the site using a surface drainage system. A Riverine Utility Craft of the type successfully used in the field studies has been acquired by the Mobile District for use in future dewatering activities. Methods are being developed to subsequently borrow the dewatered dredged material from within the disposal area interior and transport the material to the site perimeter, allowing its use in dike raising.

#### New Orleans District

48. The New Orleans District (ND) accounts for the largest volume of material dredged annually by any CE District. A majority of dredging within the ND is performed on the lower Mississippi River and in the vicinity of Head of Passes. Generally, the ND has been required to rely more on confined or partially confined land disposal than in past years but does not have great difficulty in acquiring needed easements due to the remoteness of the area. There are a few isolated disposal areas in which capacity is running short; however, in general, there seem to be only limited applications for DARM in the near future. The ND personnel did state that in future years DARM concepts may be required if a severe constraint is placed on acquisition of additional disposal areas as has happened in other regions.



### Galveston District

49. The Galveston District (GD) is responsible for maintenance of an extensive coastal navigation system including a network of 15 deep-water ports, 260 miles of deep-draft channels, and 720 miles of shallow-draft channels. The GD has been allowed in the past to maintain the extensive portions of shallow-draft channels comprising the Gulf Intra-coastal Waterway (GIWW) by simply casting the material to the bayside and allowing the flow of the carrier water directly into the bay. This activity has been restricted and the material, in many cases, must now be placed in confined disposal areas on the landside. In addition, disposal requirements of large quantities of material from the Houston Ship Channel and other deepwater ports and channels have forced the GD to utilize confined land disposal sites to a greater extent. The GD is approaching a situation in which restoration of existing disposal areas may become an attractive alternative.

50. The GD generally views DARM as a technically feasible means for extending disposal area life. The comparative costs involved in removal of material from existing sites as opposed to acquisition of new sites was considered to be the primary issue in implementation of DARM concepts. Expenditure of District funds on rejuvenation of disposal areas which are the responsibility of the respective local sponsors was opposed. In these cases, District personnel recommended sponsor participation in required activities to restore disposal area capacity.

51. Identification of selected disposal sites thought to have potential for possible rejuvenation was made by GD personnel. These sites are described in subsequent paragraphs and particular constraints associated with DARM implementation are outlined.

#### GIWW

52. Bayside placement of dredged material has created numerous islands along the GIWW which are still used for unconfined disposal. In some instances the disposal areas have been partially or totally diked. Constraints associated with restoration of these sites include limited accessibility and uncertainty over ownership of dredged

material. Dredged material placed in the sites consisted of fine sand, silts, and clays.

#### Corpus Christi Ship Channel

53. Disposal areas for maintenance dredging of the Corpus Christi Ship Channel are provided by the project sponsor, the Nueces County Navigation District No. 1. Predominantly fine-grained material from the project has been placed in two disposal areas comprising a total area of 560 acres which is essentially filled to capacity. The GD expressed interest in drying and densification of the dredged material at these sites and restoration of disposal capacity through DARM concepts. Land access to the sites is available.

#### Port Arthur Canal

54. Disposal areas for maintenance dredging of the Port Arthur Canal are provided by the project sponsor, the Beaumont Navigation District. One disposal area is filled to capacity and is identified by the Galveston District as a potential site for implementation of DARM concepts. The site encompasses an area of 550 acres and is filled with fine sands, silts, and clays. Land access to this site is available.

#### Galveston Harbor

55. Maintenance material from the Galveston Harbor Inner Bar Channel is placed in two Federally owned sites, the Pelican Island and San Jacinto Disposal Areas. These sites have remaining capacity of 14 and 25 years, respectively. The San Jacinto site has been completely filled on the eastern portion and is covered with a fine stand of vegetation. Land access to the San Jacinto site is excellent and material could be removed from this area without dewatering requirements. The GD considers both sites to have high potential for rejuvenation because of Federal ownership. However, a suitable market for the material has not been identified and precludes large-scale removal of material from the sites at this time.

#### Houston Ship Channel

56. The 51-mile-long Houston Ship Channel requires extensive use of confined disposal areas. A total of 27 confined disposal areas have been provided by the project sponsor, the Houston Port Authority,

for maintenance of the upper portion of the channel from Galveston Bay to Houston. The shoaling rate for the project is approximately 4.5 million cu yd annually, consisting of fine sands, silts, and clays.

57. Medium to fine sand has been periodically removed from the confined disposal areas and sold to private contractors for use as landfill for over 20 years. Approximately 500,000 cu yd has been removed to date, based on available records.<sup>16</sup> A flat fee of \$0.15/cu yd is charged regardless of volume sold or quality of the material involved. The Houston Port Authority recognizes that removal of sand contributes to restoration of disposal capacity and is actively promoting such programs. In addition the Houston Port Authority is planning to implement dewatering programs patterned after those developed under the DMRP to process fine-grained material for eventual removal.<sup>17</sup> Markets for such material should be available in future years in the Houston area due to increased urban development and storage of conventional sources of fill material. In addition, the Houston Ship Channel lies within an area of regional subsidence which is expected to continue. This factor greatly increases the potential need for landfill activity, creating large markets for dewatered dredged material.

#### Sacramento District

58. Dredging within the Sacramento District is conducted in the Sacramento River shallow- and deep-draft channels, extending from Suisun Bay to Red Bluff, California, in the San Francisco Bay to Stockton channels, and in the San Joaquin River channel. The dredged material encountered in these projects is entirely a coarse-grained sand. The entire disposal requirement is met by seven disposal areas, three provided by local sponsors, with the remaining five sites Federally owned. A summary of disposal area data is presented below.

59. The Sacramento District has been implementing DARM as an integral part of the dredging program for over 8 years. Disposal capacity of the confined areas is periodically restored in total through removal of all accumulated material from the sites. These sites, therefore,



<u>Disposal Area</u>	<u>Owner</u>	<u>Material Removed Since 1968,* cu yd</u>
Sacramento Weir	CE	800,000
Track 7	CE	Undetermined
Track 10	State of California	Undetermined
Track A100	CE	Undetermined
Track 125	Port of Sacramento	Undetermined
Grand Isle	CE	14 million
Rio Vista	CE	5 million
Stockton	CE (joint) Port of Stockton	Undetermined

\* Records of yardages are approximate. Material has been removed on several occasions from sites designated "undetermined."

possess an infinite design life. This program of complete restoration is made possible due to the relatively small quantity of required disposal (approximately 1.2 million cu yd annually) and the quality of material dredged. Primary use of the material is as a road fill. A typical disposal area after removal of material is shown in Figure 9.



Figure 9. Track 125 disposal area rejuvenated through removal of dredged material, Sacramento District

60. Agreements have been formulated between the Sacramento District and the California Division of Highways (CDH) for removal of the material from Federally owned sites. The CDH accomplishes the removal at its own expense using conventional equipment, and in some instances, conveyor belts and barges to transport the material to distant highway fill projects. Large removal operations have been contracted through the CDH. A typical operation for the Grand Isle site is shown in Figure 10.



Figure 10. Dredged material conveyor system and loading terminal, Grand Isle disposal area, Sacramento District

61. Material removed from areas owned by the local sponsor has been used as fill by both the CDH and the respective sponsors. Sales of material to a private contractor have also been made by the Port of Sacramento from the Track 125 site.<sup>7</sup> In all cases, removal was accomplished at the expense of CDH or the respective local sponsor.

62. It appears that the Sacramento District has developed a model program for the specific conditions existing in that area. Dredging requirements are such that no substantial change in present operations

are necessary. Due to the quality of dredged material involved, no active operations at the sites, i.e., dewatering or treatment, will be required to continue the present DARM program.



### PART III: POTENTIAL APPLICATION OF DARM

63. The shortage of adequate confined disposal capacity in critical areas throughout the Nation indicates the need for improvement of present land disposal practices. Of the nine Districts contacted during the survey, six indicated that disposal capacity at critical sites would be exhausted in the near future. The remainder of the Districts indicated that conditions would become critical in future years for many areas.

64. Large-scale implementation of DARM programs may relieve shortages of disposal area capacity in selected areas, reducing or delaying requirements for acquisition of additional lands for disposal areas.

The degree of potential application available is dependent upon:

- a. Evaluation of DARM alternatives in planning and design of containment areas.
- b. Expansion of present DARM programs.
- c. Solution of technical constraints through ongoing research.
- d. Identification of suitable markets and/or uses for dredged material products.
- e. Specific changes in present policy toward dredged material disposal and disposal area ownership.

These factors are discussed in the following paragraphs.

#### Evaluation of DARM Alternatives in Planning and Design

##### Design of new reusable sites

65. A majority of Districts experiencing shortages of confined disposal capacity are seeking additional disposal areas to meet future requirements. The consideration of DARM in the planning and design of the newly acquired sites can be evaluated as a separate alternative to conventional disposal. Factors which should be considered in planning and design of reusable disposal areas are illustrated in Figure 11. Many of the problems associated with confined dredged material disposal and the acute shortage of confined disposal capacity, as determined in

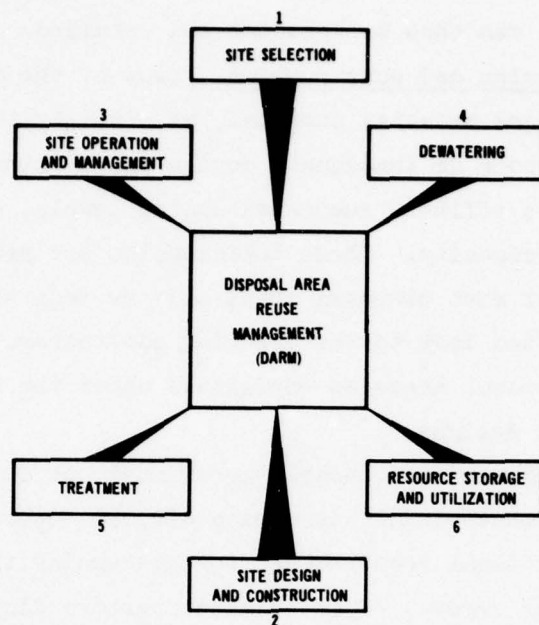


Figure 11. Considerations for area reuse planning and design

the survey of Districts, can be addressed through proper evaluation of these factors. Each of the factors are briefly discussed in general terms in the following paragraphs.

66. Site selection. Site selection for dredged material disposal areas is now greatly influenced by the nature of disposal operations. Disposal areas are usually acquired through temporary easements. Material is placed for a number of years until the storage capacity is exhausted, and the areas are then left in a useless condition for long time periods. Because of this practice, many sites are selected with little regard as to their desirability from a technical standpoint. Land which is undesirable for commercial or industrial development, with poor access and poor foundation conditions, is often the only land made available for dredged material disposal.

67. Under the DARM concept, site selection can be greatly influenced by the fact that the area will be active for long periods of time and will be a long-term source of usable fill material. Sites more desirable from a technical standpoint and more convenient to the

dredging operation can then be selected and retained.

68. Site design and construction. Many of the problems associated with confined dredged material disposal, as cited by the District survey, are the result of poor or inadequate design and construction, e.g., dike failures, excessive effluent suspended solids levels, and inadequate long-term storage capacity. These deficiencies are partially due to the temporary nature of most disposal areas and the fact that design and construction is often left to the dredging contractor. The more permanent nature of disposal areas as envisioned under the DARM concept will encourage improved designs.

69. The designers of reusable areas must not only consider all requirements for conventional use during disposal operations, but must also consider additional requirements for processing the material and later rehandling or removal of material to restore disposal capacity. As a minimum, dewatering of fine-grained material should be considered along with economical means to rehandle and/or transport the dewatered material. In some cases, separation of coarse- and fine-grained material, or treatment of material, should also be considered.

70. Design of containment areas for conventional use in disposal operations includes sizing for retention of solids and to provide adequate long-term storage capacity, location and design of outlet weirs, and provisions for operation and management of the containment area. Guidelines for containment area design, operation, and management have been developed by the DMRP and should be considered as a necessary first step in design.<sup>18</sup> Design guidelines for development of reusable disposal areas have also been developed and can be used to evaluate DARM alternatives on an economical and technical basis.<sup>5</sup>

71. Site operation and management. The operation of conventional disposal areas is limited to that period of time in which disposal operations are actually occurring, with the areas largely abandoned between operations. This practice leads to higher maintenance requirements and can result in loss of potential gains in storage capacity through effective evaporation. Implementation of DARM requires an active participation in management of the site to promote effective



dewatering and rehandling/removal of usable material. Such an active degree of management will encourage better maintenance and effective use of storage capacity.

72. Dewatering. The removal of water will be essential in the transformation of a dredged material slurry into a usable resource material and is instrumental in the densification of dredged material and extension of disposal area service life. Also, dredged material must be in an essentially dewatered condition to exhibit desirable properties for removal offsite for productive use. Dewatering is therefore a most important aspect of any disposal area reuse scheme.

73. The fine-grained dredged material presents the most difficult problem in this area. The most cost-effective dewatering procedures are aimed at increasing efficiency of natural evaporative processes to dry the material between dredging phases. These procedures are best implemented as part of an overall site management plan which may include eventual rehandling/removal of the dewatered material (DARM). Guidelines for dewatering fine-grained dredged material have been developed and can be used in planning and design of reusable disposal areas.<sup>19</sup>

74. Treatment. Many of the uses for dredged material removed from reusable disposal areas require that it be relatively free from contaminants. Therefore, some treatment of the material itself and effluent water may be a required operation at reusable areas. Contaminants found in dredged material are often similar to those present in domestic and/or industrial wastewaters. However, treatment processes may be substantially different due to the large quantities of dredged material, its variable nature, and the unusually high percentage of solids as compared with most wastewaters.

75. The DMRP has developed methods for characterization of contaminants and treatment of dredged material effluents.<sup>20</sup> The more permanent nature of reusable sites can economically justify limited treatment of effluents and/or the usable material later removed to restore site capacity. Treatment may also include the blending of various types of dredged sediments to meet particular requirements for productive uses.

76. Resource storage and utilization. A major consideration of the area reuse concept is the use or disposal of materials necessary to permit reuse of the facility. Productive use of dredged material off-site can contribute to the possible removal of material and restoration of capacity in disposal areas. The most obvious use of the dried material is for landfill and construction purposes. Once dewatered dredged material exhibits engineering properties similar to in situ soils, dredged material is acceptable as landfill material. Productive use of material as an agricultural enhancement or use in habitat development is also possible for offsite use.<sup>21,22</sup> The useful life of disposal areas can be greatly increased without actual removal of the material offsite. In addition to required dewatering, other actions can be taken to substantially densify the dredged material mass within the disposal area. The material can be rehandled and used to create onsite landfills or mounds. Not only is the material densified, but the potential use of the site is greatly enhanced due to increased bearing capacity. The landfill or mound creation also makes the site more aesthetically pleasing and environmentally compatible and therefore more acceptable to adjacent land owners.

Rejuvenation and  
reuse of existing sites

77. Rejuvenation of existing sites involving removal of material and restoration of site capacity is another available DARM alternative. Large-scale technical feasibility has been proved by the Sacramento District program. Partial rejuvenation through removal of the usable portions of material from sites has also been implemented in a number of Districts. The storage capacity of existing disposal areas is controlled by the limitations now placed on dike heights due to political/institutional constraints or foundation conditions. Existing commitments of a political or institutional nature are difficult to amend; however, the limitations imposed by dike stability should always be examined using the actual field conditions.

78. Foundation conditions used in establishing limits for dike heights are in many instances based on field data taken before dikes

are constructed. In most cases the foundation conditions indicated by these data have improved due to consolidation of dikes and foundation soils. Reanalysis of dike stability using results of new borings may lead to higher allowable dike heights and resulting increases in containment area service life. If dikes can be raised, usable material from within the disposal area should be used to upgrade the dikes, thereby adding to the available storage capacity. This is already standard practice for a number of Corps Districts.

#### Expansion of Present DARM Programs

79. Usable portions of dredged material have been sold or donated from disposal areas throughout the Nation, thereby restoring disposal area capacity and providing revenue to the government or respective local sponsor. The most notable programs of this type have been implemented in the Philadelphia and Sacramento Districts where sale and use programs have significantly increased the remaining capacity of disposal areas. Specific sites in many other areas of the country have enjoyed similar success on a smaller scale. Contributing factors to successful implementation of such programs appear to be the quality of dredged material involved, the local demand for usable material, and the interest of the District or local sponsor controlling removal of the material.

80. The magnitude of present programs of this type has been dependent upon the immediate demand of users. Such programs could be significantly increased if availability of usable material is made known to a greater number of potential users. The general trends for demand of landfill material have been established by previous DMRP research, and concerned agencies have been identified as potential users.<sup>23</sup>

#### Technical Constraints

81. The physical characteristics of confined disposal areas and the condition or properties of the dredged material within the areas present unique constraints on the removal and subsequent use of the



material. Principal technical constraints include dewatering fine-grained material and removal and/or transport of dewatered material from within large disposal areas. Ultimate uses of dredged material, including random landfill applications, require that the material be in an essentially dewatered condition. A majority of maintenance dredged material is fine-grained silts or clays, which are difficult to dewater. Guidelines have been developed by the DMRP for methods for dewatering fine-grained dredged material.<sup>19</sup>

82. Rehandling/removal of the dewatered material to awaiting transport systems or stockpile areas is also an essential aspect of implementation of DARM concepts. Successful large-scale ongoing programs in the Sacramento and Philadelphia Districts have utilized conventional earthmoving techniques linked to both land and waterborne transport systems. In these cases, the disposal areas were essentially dewatered with high-bearing capacities allowing access of conventional equipment. In other cases, dewatered material may be only present in the form of surface crusts, and underlying weak material may require use of specialized removal systems not yet field tested in dredged material disposal areas. Research by the DMRP has been initiated concerning dredged material transport systems applicable to DARM concepts.<sup>24</sup>

#### Identification of Dredged Material Markets

83. The DARM concepts which include rehandling material for placement in onsite stockpile areas, perimeter mounding schemes, or on-site landfills have potential for greatly extending disposal area life.<sup>3</sup> However, the DARM concepts yielding the largest increases in disposal capacity involve the complete removal of material from the site for uses elsewhere. Identification of suitable markets is essential in DARM programs requiring eventual removal of material. Survey of the Districts has shown that material in a usable condition, primarily sands, is already compatible with existing markets in most areas. Markets for large quantities of fine-grained material present the real challenge. More than half of the Districts surveyed indicated

market identification for fine-grained material as a major constraint in implementing DARM on a large scale.

84. The most promising market for dredged material is landfill applications.<sup>22</sup> Increasing urban development with resulting restrictions on land use will have a great effect on the future availability of fill material from conventional pits. Dredged material will undoubtedly experience a greater demand for use as landfill in these areas.

85. Other potential uses and subsequent markets for dredged material are being identified and developed by DMRP research concerning productive uses of dredged material.<sup>25,26</sup>

#### Need for Policy Changes

86. Present philosophy and policy regarding dredged material disposal are sometimes in conflict with the most efficient use of available disposal area resources. Legal and policy constraints regarding sale and use of dredged material, removal of dredged material from disposal areas, and ownership of dredged material were identified by six Districts surveyed.

87. A greater degree of flexibility regarding removal of dredged material and sales or donations of material was evident in cases of Federal ownership of disposal areas. In both the Philadelphia and Sacramento Districts, where large-scale DARM programs are developed, sites are Federally owned. When disposal areas are owned by project sponsors, usually local or State agencies, questions arise as to legal jurisdiction and ownership of dredged material placed in the sites. The issue becomes more complex when easements are secured on private lands by State or local sponsors for disposal by Federal authority. The DMRP has completed research identifying major legal and policy constraints in this area.<sup>27</sup> More consideration should be given to Federal ownership of disposal areas, considering the long-term savings made possible by implementation of DARM practices.

88. In instances where easements are secured on private lands or lands are provided directly by local sponsors, acquisition of the site

is granted on conditions relating to ultimate return of the site to the private owner or local sponsor. Return is usually tied to an expiration date for easement or achievement of a maximum fill elevation within the disposal area. Opposition by owners or sponsors to removal of dredged material from such sites is understandable since higher elevations gained by disposal operations greatly increase land values and potential for future development. Disposal areas acquired with eventual return to owner or sponsor are suited to DARM concepts involving onsite landfill or perimeter mounding. Such operations would usually add greater value to the lands by providing suitable foundation conditions for heavier construction and greater aesthetic benefits.

89. Expansion of present sales and donation programs to other areas is hindered by constraints imposed by both Federal law and Corps policy. Sale of dredged material from disposal areas is usually through a competitive bidding process, considering the material as excess government property. Similar procedures, governed by State law or local ordinance, are used in sales through the project sponsors. These procedures are effective for large quantities when the market is present, reflected by high demand. However, the procedure is not well suited to the sale of smaller lots or when quick access to the material is required by the user. In such cases direct negotiation between the user and District or project sponsor would be more appropriate and would encourage more frequent sales of material.

90. In cases where material is sold as excess government property from Federally owned sites, revenue is received by the GSA. Diversion of these funds to the District operations and maintenance budget would encourage increased promotion by the Districts of such programs and would allow greater use of resources for management of disposal operations. If funds from sales were diverted to the Districts, problems with timing may arise. Present requirements to expend all available funds within a fiscal year may prevent the most judicious use of the funds. Resolution of these problems would require an exception to or the reform of present overall funding policies.



#### PART IV: CONCLUSIONS AND RECOMMENDATIONS

##### Conclusions

91. Based on results of the District survey, the following general conclusions are made regarding the potential application of DARM in confined disposal areas:

- a. Critical shortages of confined disposal capacity now exist in many areas throughout the country. Many long-range disposal plans, as presently developed, rely on the acquisition of additional land for new disposal areas and are subject to social or environmental constraints.
- b. Acquisition of additional conventional disposal areas is viewed by most Districts as the most economical solution to shortages of disposal capacity, especially in instances when disposal areas are provided in total by the local sponsor. When additional sites are available, DARM has little chance of being economically justified.
- c. Districts are generally reluctant to initiate expenditure of government funds to restore sites through DARM in cases where provision of disposal sites is viewed as the sole responsibility of the local sponsor. It is also realized that in most cases, local sponsors do not possess the financial capability of initiating DARM practices.
- d. Where responsibility for providing disposal sites lies with the government, DARM is generally viewed as a viable alternative to acquisition of additional sites, providing technical constraints can be resolved and economic feasibility can be determined.
- e. In areas where technical and economic factors are favorable, many Districts have already initiated DARM concepts and have developed successful programs which contribute to extension of disposal area capacity.
- f. The DARM practices are now viable alternatives to conventional disposal practices in areas where acquisition of additional disposal sites is expensive or impossible due to environmental or other constraints. The DARM alternative will become more viable in future years as easily acquired sites are depleted and urbanization and navigational requirements increase.

92. The following conclusions are made regarding the technical feasibility of implementing DARM concepts:

- a. The technical feasibility of large-scale removal and subsequent use of dredged material has been demonstrated by the success of the Philadelphia and Sacramento District programs. These programs involved primarily coarse-grained material in a ready-to-use condition. In areas where fine-grained material predominates, additional technical constraints concerning dewatering, removal, and transport must be resolved before DARM concepts may be implemented on a large scale.
- b. Mechanical separation of the fine and coarse fractions of dredged material is generally viewed as unnecessary by District personnel. The natural settling process occurring during disposal usually results in sufficient separation of the coarse fraction near the outlet pipe to allow its removal and use for dike raising or other purposes. Small basins may be feasible to enhance the separation process or allow continuous removal of coarse-grained material during the disposal process.
- c. Dewatering large quantities of fine-grained material within disposal areas is viewed by the Districts as a major constraint on implementation of DARM. Dewatering techniques must be developed which are both technically and economically feasible.
- d. Removal of material from the interior of disposal areas and subsequent transportation to users is considered a major constraint. This is especially critical in cases where fine-grained material is involved and material bearing capacities within the site are low. Many disposal areas are also located in remote areas and cannot be easily linked to existing transportation systems.
- e. Users and markets for coarse-grained dredged material have been identified. However, suitable uses for large quantities of fine-grained material, even in a dewatered condition, have not been identified in many instances. Applications for agricultural purposes, sanitary landfill cover, and random fill hold promise and must be examined more closely in light of DMRP research, and additional productive uses must be identified.

93. The following conclusions are made regarding present policy and its effects on potential application of DARM:

- a. In instances where sites are Federally owned, more flexibility in implementing DARM concepts is possible, especially concerning time constraints which may effect the long-term use of the sites. By definition, DARM is aimed at the extension of disposal area life to the greatest possible extent, a concept which is often in direct conflict with other interests. Local sponsors

frequently acquire sites with future potential for industrial or commercial development and these sites are destined for a finite design life. This constraint is even more apparent in cases where disposal easements are in effect on privately owned lands.

- b. Many Federally owned sites are acquired with formal, or informal agreements with State or local authorities concerning transfer of ownership after the site is filled to a specified elevation. This policy is also in direct conflict with DARM concepts.
- c. Removal of material from Federally owned sites for productive use is often accomplished by private contractor and involves sale of the material as excess government property. Revenues derived from such sales now go to the general treasury and such practices provide little incentive to the District to initiate or expand such programs.
- d. Administrative procedures involving sale of material including advertisement, award, and other contractual requirements are usually time-consuming and are not tailored for transactions of the type involved in DARM. The sale of material to contractors is often dependent on short-notice sales which are not possible with present procedures.

#### Recommendations

94. The following recommendations are made regarding potential application of DARM in confined disposal areas:

- a. It is recommended that long-range disposal plans for Federally owned sites be reexamined by Districts in light of this and other DMRP research pertaining to DARM. Consideration should be given to revision of these plans to include those DARM practices which are technically and economically feasible and have potential to extend disposal area life.
- b. In view of the increasing difficulty in acquisition of disposal areas, it is recommended that long-range disposal plans give preference to acquisition of Federally owned sites or sponsor owned sites with the greatest potential for long-range or perpetual use. Temporary easements for disposal on privately owned land should be utilized only when Federally owned or sponsor owned sites are not feasible.
- c. In areas where local sponsor owned sites are now in



use, it is recommended that the sponsor be acquainted with results of DMRP research on DARM so that evaluations of possible implementation of DARM practices by the sponsor can be made.

- d. It is recommended that a reexamination of certain policy constraints be made in light of research so that constraints on DARM practices may be minimized. Possible changes would include direct negotiation of dredged material sales, authorization for District authority for such sales, and diversion of revenues from such sales to the District dredging budget.
- e. In selecting new disposal areas, it is recommended that sites should be located with convenient access to existing transportation links. This would allow easier implementation of DARM concepts which call for removal of material offsite.
- f. It is recommended that Districts make a realistic evaluation of the potential market for productive use of dredged material, especially uses for random land-fill applications.

#### REFERENCES

1. Boyd, M. B. et al., "The Disposal of Dredge Spoil, Problem Identification and Assessment, and Research Program Development," Technical Report H-72-8, Nov 1972, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
2. Murphy, W. L. and Zeigler, T. W., "Practices and Problems in the Confinement of Dredged Material in Corps of Engineers Projects," Technical Report D-74-2, May 1974, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
3. Palermo, M. R. and Montgomery, R. L., "A New Concept for Dredged Material Disposal," Miscellaneous Paper D-76-15, Feb 1976, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
4. Montgomery, R. L. and Palermo, M. R., "First Steps Toward Achieving Disposal Area Reuse," Miscellaneous Paper D-76-16, Apr 1976, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
5. Ford, A. W. et al., "Guidelines for Dredged Material Disposal Area Reuse Management," in preparation, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
6. "Long Range Spoil Disposal Study," U. S. Army Engineer District, Philadelphia, Penn., Jun 1969.
7. "Public Notice SPKCO-O #455," U. S. Army Engineer District, Sacramento, Calif., Nov 1969.
8. "Sections 148 and 150 and the DMRP," Dredged Material Research Notes, News, Reviews, etc., Information Exchange Bulletin, Vol D-77-1, Jan 1977, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
9. "Final Composite Environmental Impact Statement, Project Maintenance, Delaware River....," U. S. Army Engineer District, Philadelphia, Penn., 1975.
10. "Final Environmental Statement, Maintenance of Charleston Harbor....," U. S. Army Engineer District, Charleston, South Carolina, Mar 1976.
11. "Long Range Dredging and Disposal Study," U. S. Army Engineer District, Charleston, South Carolina, 1974.
12. "RUC Demonstration for Charleston District," Dredged Material Research Notes, News, Reviews, etc., Information Exchange Bulletin, Vol D-76-2, Jan 1976, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
13. "Final Environmental Statement, Operation and Maintenance of Savannah Harbor, Georgia," U. S. Army Engineer District, Savannah, Georgia, Dec 1976.

14. "Final Environmental Impact Statement, Jacksonville Harbor (Maintenance Dredging)," Office of the Chief of Engineers, Washington, D. C., Apr 1975.
15. "Final Environmental Statement, Mobile Harbor (Maintenance Dredging), Mobile County, Alabama," U. S. Army Engineer District, Mobile, Ala., Apr 1975.
16. "A Fifty-Year Program for the Disposal of Dredged Materials from Certain Inland Reaches of the Houston Ship Channel," Port of Houston Authority of Harris County, Tex., Jul 1976.
17. "A Proposed Dredged Materials Processing Management Program," The Port of Houston Authority of Harris County, Tex., Mar 1977.
18. Palermo, M. R., Montgomery, R. L., and Poindexter, M. E., "Guidelines for Designing, Operating, and Managing Dredged Material Containment Areas," in preparation, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
19. Haliburton, T. A., "Guidelines for Dewatering/Densifying Confined Dredged Material," in preparation, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
20. Barnard, W. B. and Hand, T., "Treatment of Contaminated Dredged Material," in preparation, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
21. Gupta, S. C. et al., "Agricultural Value of Dredged Material," in preparation, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
22. Smith, H. K., "Introduction to Habitat Development on Dredged Material," in preparation, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
23. Reikenis, R. et al., "Regional Landfill and Construction Material Needs in Terms of Dredged Material Characteristics and Availability," Contract Report D-74-2, Vol I and II, May 1974, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
24. Soudor, P. S., Tobias, L., and Mushal, F. C., "Dredged Material Transport Systems for Inland Disposal and/or Productive Use Concepts," in preparation, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
25. Spaine, P. A. and Llopis, J., "Land Improvement Concepts in Inland Disposal of Dredged Material," in preparation, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
26. Walsh, M. R. and Malkasian, M., "Productive Land Use of Dredged Material Containment Areas," in preparation, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
27. Wakeford, R. C. and MacDonald, D., "Legal, Policy, and Institutional Constraints Associated with Dredged Material Marketing and Land Encroachment," Contract Report D-74-7, Dec 1974, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.



Table 1

Disposal Area Summary, Delaware RiverPhiladelphia District

<u>Disposal Area</u>	<u>Area acres</u>	<u>Method of Aquisition</u>	<u>Approximate Remaining Capacity, cu yd</u>
Philadelphia to the Atlantic Ocean			
Artificial Island	400	Federal ownership	28.8 million
Killcohook	1182	↓	32.9 million
Penns Neck	322		8.0 million
Penns Grove	253		21.9 million
Pedricktown	1129		37.9 million
National Park	115		3.6 million
Fort Mifflin	298		2.5 million
Trenton to Philadelphia			
2	65	Easement	1.4 million
4	150	↓	3.2 million
12A	72		1.7 million
14	21		0.3 million
22	71		0.6 million
24	249		2.7 million
24D	50		0.6 million
28A	27		2.0 million
Wilmington Harbor	160	Partial Easement	3.6 million
Edgemoor	230	Partial Easement	2.5 million

Table 2  
Summary of Sales of Fill Material from Disposal Areas  
Philadelphia District

<u>Disposal Area</u>	<u>Bid/cu yd</u>	<u>cu yd</u>	<u>Date Awarded</u>
Pedricktown	\$0.11	300,000	Oct 72
National Park	0.11	10,000	Jul 73
National Park	0.12	300,000	Jul 73
Fort Mifflin	0.25	150,000	Jan 73
Fort Mifflin	0.82	100,000	Jan 73
Penns Grove	0.40	30,000	Oct 73
Penns Grove	0.35	300,000	Aug 73
National Park	0.12	60,000	Sep 73
National Park	0.10	17,000	Dec 73
Penns Neck	0.15	25,000	Jan 74
Penns Grove	0.08	4,500,000	May 74
Pedricktown	0.40	5,000	May 74
National Park	0.10	15,000	Jun 74
Pedricktown	0.25	2,000	Nov 75
Pedricktown	Donated	1,000,000	May 76

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Palermo, Michael R

Needs and areas of potential application of Disposal Area Reuse Management (DARM) / by Michael R. Palermo. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.

44, 22 p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; D-78-27)

Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., under DMRP Work Unit No. 5C09.

References: p. 43-44.

1. Disposal Area Reuse Management. 2. Dredged material.
  3. Dredged material disposal. 4. Waste disposal sites.
  - I. United States. Army. Corps of Engineers. II. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; D-78-27.
- TA7.W34 no.D-78-27